CLAIMS

1. A high-frequency power supply system for supplying high-frequency power from a high-frequency power source to a load via an impedance matching unit, the system comprising:

a first detector for detecting information about a forward wave traveling from the high-frequency power source toward the load;

a second detector for detecting information about a reflected wave traveling from the load toward the high-frequency power source;

a differentiator for calculating a change of a magnitude of reflection coefficient per unit time at a detection point provided for the first and the second detectors based on the information about the forward wave detected by the first detector and the information about the reflected wave detected by the second detector; and

an anomaly determiner for determining an occurrence of an anomaly on a side toward the load as from the detection point provided for the first and the second detector based on the change of the magnitude of reflection coefficient per unit time calculated by the differentiator.

2. The high-frequency power supply system according to claim 1, wherein the anomaly determiner determines the occurrence of anomaly when the change of the magnitude of reflection coefficient per unit time exceeds a first predetermined

reference value.

3. The high-frequency power supply system according to claim 1, wherein the anomaly determiner includes a counter for counting the number of times when the change of the magnitude of reflection coefficient per unit time exceeds a first predetermined reference value, and determines the occurrence of anomaly when the number of times counted by the counter exceeds a predetermined norm number.

4. The high-frequency power supply system according to claim 1, further comprising a calculator for calculating a magnitude of reflection coefficient at the detection point provided for the first and the second detector based on the information about the forward wave detected by the first detector and the information about the reflected wave detected by the second detector,

wherein the anomaly determiner determines the occurrence of anomaly on the side toward the load as from the detection point of the first and the second detector based on the change of the magnitude of reflection coefficient per unit time calculated by the differentiator and the magnitude of reflection coefficient calculated by the calculator.

5. The high-frequency power supply system according to claim 4, wherein the anomaly determiner determines the occurrence of anomaly when the magnitude of reflection coefficient

exceeds a second predetermined reference value and the change of the magnitude of reflection coefficient per unit time exceeds a first predetermined reference value.

6. The high-frequency power supply system according to claim 4, wherein the anomaly determiner includes: a first counter for counting the number of times when the change of the magnitude of reflection coefficient per unit time exceeds a first predetermined reference value; and a second counter for counting the number of times when the magnitude of reflection coefficient exceeds a second predetermined reference value; and determines the occurrence of anomaly when the number of times counted by the first counter exceeds a first predetermined norm number and the number of times counted by the second counter exceeds a second predetermined norm number.

7. The high-frequency power supply system according to claim 1, wherein the detection point provided for the first and the second detectors is inside the high-frequency power source, in a transmission line from a high-frequency power outputting end of the high-frequency power source to a high-frequency power inputting end of the impedance matching unit, or inside the impedance matching unit.

8. A high-frequency power supply system for supplying high-frequency power from a high-frequency power source to a load via an impedance matching unit, the system comprising:

a first detector for detecting information about a forward wave traveling from the high-frequency power source toward the load;

a second detector for detecting information about a reflected wave traveling from the load toward the high-frequency power source;

a first differentiator for calculating a change per unit time of a magnitude of reflection coefficient at a detection point provided for the first and the second detector based on the information about the forward wave detected by the first detector and the information about the reflected wave detected by the second detector;

a third detector for detecting an input voltage to the load;

fourth detector for detecting an input current to the load;

a second differentiator for calculating a change of a magnitude of impedance per unit time as viewed from a detection point provided for the third and the fourth detectors toward the load based on the input voltage detected by the third detector and the input current detected by the fourth detector; and

an anomaly determiner for determining an occurrence of an anomaly on a side toward the load as from the detection point provided for the third and the fourth detector based on the change of the magnitude of reflection coefficient per unit time calculated by the first differentiator and the

change of the magnitude of impedance per unit time calculated by the second differentiator.

9. The high-frequency power supply system according to claim 8, wherein the anomaly determiner determines the occurrence of anomaly when the change of the magnitude of reflection coefficient per unit time exceeds a first predetermined reference value and the change of the magnitude of impedance per unit time exceeds a third predetermined reference value.

10. The high-frequency power supply system according to claim 8, wherein the anomaly determiner includes:

a first counter for counting the number of times when the change of the magnitude of reflection coefficient per unit time exceeds a first predetermined reference value;

a third counter for counting the number of times when the change of the magnitude of impedance per unit time exceeds a third predetermined reference value; and

wherein the anomaly determiner determines the occurrence of anomaly when the number of times counted by the first counter exceeds a first predetermined norm number and the number of times counted by the third counter exceeds a third predetermined norm number.

11. The high-frequency power supply system according to claim 8, further comprising a calculator for calculating a magnitude of reflection coefficient at the detection point

provided for the first and the second detectors based on the information about the forward wave detected by the first detector and the information about the reflected wave detected by the second detector,

wherein the anomaly determiner determines the occurrence of anomaly on the side toward the load as from the detection point of the third and the fourth detectors based on the change of the magnitude of reflection coefficient per unit time calculated by the first differentiator, the magnitude of reflection coefficient calculated by the calculator and the change of the magnitude of impedance per unit time calculated by the second differentiator.

12. The high-frequency power supply system according to claim 11, wherein the anomaly determiner determines the occurrence of anomaly when the change of the magnitude of reflection coefficient per unit time exceeds a first predetermined reference value, the magnitude of reflection coefficient exceeds a second predetermined reference value and the change of the magnitude of impedance per unit time exceeds a third predetermined reference value.

13. The high-frequency power supply system according to claim 11, wherein the anomaly determiner includes:

a first counter for counting the number of times when the change of the magnitude of reflection coefficient per unit time exceeds a first predetermined reference value;

a second counter for counting the number of times when the magnitude of reflection coefficient exceeds a second predetermined reference value; and

a third counter for counting the number of times when the change of the magnitude of impedance per unit time exceeds a third predetermined reference value; and

wherein the anomaly determiner determines the occurrence of anomaly when the number of times counted by the first counter exceeds a first predetermined norm number, the number of times counted by the second counter exceeds a second predetermined norm number and the number of times counted by the third counter exceeds a third predetermined norm number.

14. The high-frequency power supply system according to claim 8, wherein the detection point provided for the first and the second detectors is inside the high-frequency power source, in a transmission line from a high-frequency power outputting end of the high-frequency power source to a high-frequency power inputting end of the impedance matching unit, or inside the impedance matching unit, the detection point provided for the third and the fourth detectors being in a transmission line from inside the impedance matching unit to the load.

15. A high-frequency power supply system for supplying high-frequency power from a high-frequency power source to a load via an impedance matching unit, the system comprising:

a first detector for detecting information about a

forward wave traveling from the high-frequency power source toward the load;

a second detector for detecting information about a reflected wave traveling from the load toward the high-frequency power source;

a logarithmic reflection coefficient calculator for calculating a logarithm value of a reflection coefficient at a detection point provided for the first and the second detectors based on the information about the forward wave detected by the first detector and the information about the reflected wave detected by the second detector;

a logarithmic reflection coefficient storage for storing the reflection coefficient logarithm value calculated by the logarithmic reflection coefficient calculator in succession at a predetermined time interval; and

an anomaly determiner for determining an occurrence of an anomaly on a side toward the load as from the detection point provided for the first and the second detector based on the latest value and the previous value stored in the logarithmic reflection coefficient storage.

16. The high-frequency power supply system according to claim 15, wherein the anomaly determiner determines the occurrence of anomaly when the latest value stored in the logarithmic reflection coefficient storage is not smaller than a fourth predetermined reference value and the previous value stored in the logarithmic reflection coefficient storage is not

greater than a fifth predetermined reference value.

17. The high-frequency power supply system according to claim 15, wherein the anomaly determiner includes a fourth counter for counting the number of times when the latest value stored in the logarithmic reflection coefficient storage is not smaller than a fourth predetermined reference value and the previous value stored in the logarithmic reflection coefficient storage is not greater than a fifth predetermined reference value, and determines the occurrence of anomaly when the number of times counted by the fourth counter exceeds a fourth predetermined norm number.

18. The high-frequency power supply system according to claim 15, wherein the detection point provided for the first and the second detector is inside the high-frequency power source, in a transmission line from a high-frequency power outputting end of the high-frequency power source to a high-frequency power inputting end of the impedance matching unit, or inside the impedance matching unit.

19. A high-frequency power supply system for supplying high-frequency power from a high-frequency power source to a load via an impedance matching unit, the system comprising:

a first detector for detecting information about a forward wave traveling from the high-frequency power source toward the load;

a second detector for detecting information about a reflected wave traveling from the load toward the high-frequency power source;

a logarithmic reflection coefficient calculator for calculating a logarithm value of a magnitude of reflection coefficient at a detection point provided for the first and the second detectors based on the information about the forward wave detected by the first detector and the information about the reflected wave detected by the second detector;

a logarithmic reflection coefficient storage for storing the reflection coefficient logarithm value calculated by the logarithmic reflection coefficient calculator in succession at a predetermined time interval;

a third detector for detecting an input voltage to the load;

fourth detector for detecting an input current to the load;

a second differentiator for calculating a change of a magnitude of impedance per unit time as viewed from a detection point provided for the third and the fourth detector toward the load based on the input voltage detected by the third detector and the input current detected by the fourth detector; and

an anomaly determiner for determining an occurrence of an anomaly on a side toward the load as from the detection point provided for the third and the fourth detector based on

the latest value and the previous value stored in the logarithmic reflection coefficient storage, and the change of the magnitude of impedance per unit time calculated by the second differentiator.

20. The high-frequency power supply system according to claim 19, wherein the anomaly determiner determines the occurrence of anomaly when the latest value stored in the logarithmic reflection coefficient storage is not smaller than a fourth predetermined reference value, the previous value stored in the logarithmic reflection coefficient storage is not greater than a fifth predetermined reference value and the change of the magnitude of impedance per unit time exceeds a third predetermined reference value.

21. The high-frequency power supply system according to claim 19, wherein the anomaly determiner includes: a fourth counter for counting the number of times when the latest value stored in the logarithmic reflection coefficient storage is not smaller than a fourth predetermined reference value and the previous value stored in the logarithmic reflection coefficient storage is not greater than a fifth predetermined reference value; and a third counter for counting the number of times when the change of the magnitude of impedance per unit time exceeds a third predetermined reference value; and wherein the anomaly determiner determines the occurrence of anomaly when the number of times counted by the fourth

counter exceeds a fourth predetermined norm number and the number of times counted by the third counter exceeds a third predetermined norm number.

22. The high-frequency power supply system according to claim 19, wherein the detection point provided for the first and the second detector is inside the high-frequency power source, in a transmission line from a high-frequency power outputting end of the high-frequency power source to a high-frequency power inputting end of the impedance matching unit, or inside the impedance matching unit, the detection point provided for the third and the fourth detector being in a transmission line from inside the impedance matching unit to the load.

23. A high-frequency power supply system for supplying high-frequency power from a high-frequency power source to a load via an impedance matching unit, the system comprising:

a first detector for detecting information about a forward wave traveling from the high-frequency power source toward the load;

a second detector for detecting information about a reflected wave traveling from the load toward the high-frequency power source;

a reflection coefficient calculator for calculating a magnitude of reflection coefficient at a detection point provided for the first and the second detector based on the information about the forward wave detected by the first

detector and the information about the reflected wave detected by the second detector;

a reflection coefficient storage for storing the reflection coefficient value calculated by the reflection coefficient calculator in succession at a predetermined time interval; and

an anomaly determiner for determining an occurrence of an anomaly on a side toward the load as from the detection point provided for the first and the second detector based on the latest value and the previous value stored in the reflection coefficient storage.

24. The high-frequency power supply system according to claim 23, wherein the anomaly determiner determines the occurrence of anomaly when the latest value stored in the reflection coefficient storage is not smaller than a sixth predetermined reference value and the previous value stored in the reflection coefficient storage is not greater than a seventh predetermined reference value.

25. The high-frequency power supply system according to claim 23, wherein the anomaly determiner includes a fifth counter for counting the number of times when the latest value stored in the reflection coefficient storage is not smaller than a sixth predetermined reference value and the previous value stored in the reflection coefficient storage is not greater than a seventh predetermined reference value, and determines

the occurrence of anomaly when the number of times counted by the fifth counter exceeds a fifth predetermined norm number.

26. The high-frequency power supply system according to claim 23, wherein the detection point provided for the first and the second detector is inside the high-frequency power source, in a transmission line from a high-frequency power outputting end of the high-frequency power source to a high-frequency power inputting end of the impedance matching unit or inside the impedance matching unit.

27. A high-frequency power supply system for supplying high-frequency power from a high-frequency power source to a load via an impedance matching unit, the system comprising:

a first detector for detecting information about a forward wave traveling from the high-frequency power source toward the load;

a second detector for detecting information about a reflected wave traveling from the load toward the high-frequency power source;

a reflection coefficient calculator for calculating a magnitude of reflection coefficient at a detection point provided for the first and the second detector based on the information about the forward wave detected by the first detector and the information about the reflected wave detected by the second detector;

a reflection coefficient storage for storing the

reflection coefficient value calculated by the reflection coefficient calculator in succession at a predetermined time interval;

a third detector for detecting an input voltage to the load;

a fourth detector for detecting an input current to the load;

a second differentiator for calculating a change per unit time of a magnitude of impedance as viewed from a detection point provided for the third and the fourth detector based on the input voltage detected by the third detector and the input current detected by the fourth detector; and

an anomaly determiner for determining an occurrence of an anomaly on a side toward the load as from the detection point provided for the first and the second detector based on the latest value and the previous value stored in the reflection coefficient storage, and the change of the magnitude of impedance per unit time calculated by the second differentiator.

28. The high-frequency power supply system according to claim 27, wherein the anomaly determiner determines the occurrence of anomaly when the latest value stored in the reflection coefficient storage is not smaller than a sixth predetermined reference value, the previous value stored in the reflection coefficient storage is not greater than a seventh

predetermined reference value and the change of the magnitude of impedance per unit time exceeds a third predetermined reference value.

29. The high-frequency power supply system according to claim 27, wherein the anomaly determiner includes: a fifth counter for counting the number of times when the latest value stored in the reflection coefficient storage is not smaller than a sixth predetermined reference value and the previous value stored in the reflection coefficient storage is not greater than a seventh predetermined reference value; and third counter for counting the number of times when the change of the magnitude of impedance per unit time exceeds a third predetermined reference value; and determines the occurrence of anomaly when the number of times counted by the fifth counter exceeds a fifth predetermined norm number and the number of times counted by the third counter exceeds a third predetermined norm number.

30. The high-frequency power supply system according to claim 27, wherein the detection point provided for the first and the second detector is inside the high-frequency power source, in a transmission line from a high-frequency power outputting end of the high-frequency power source to a high-frequency power inputting end of the impedance matching unit or inside the impedance matching unit, the detection point provided for the third and the fourth detector being in a transmission

line from inside the impedance matching unit to the load.

31. The high-frequency power supply system according to one of claims 1, 8, 15, 19, 23 and 27, further comprising an output power changer for changing an electric power outputted from the high-frequency power source in a decreasing direction upon detection of an occurrence of anomaly by the anomaly detector.

32. The high-frequency power supply system according to claim 31, wherein the output power changer zeroes the electric power outputted from the high-frequency power source upon detection of the occurrence of anomaly by the anomaly detector.

33. The high-frequency power supply system according to claim 31, further comprising an output power resumption unit for bringing the electric power outputted from the high-frequency power source back to an original amount after a lapse of a first predetermined time from upon the change made by the output power changer on the output power.

34. The high-frequency power supply system according to claim 33, further comprising a matching operation stopping unit for stopping a matching operation performed by the impedance matching unit and holding operation parameters upon the change made by the output power changer on the output power

from the high-frequency power source.

35. The high-frequency power supply system according to claim 33, further comprising a first determination prevention unit for preventing the anomaly determiner from performing a determining operation upon determination of the occurrence of anomaly by the determiner, throughout a period of time while the output power changer changes the power output from the high-frequency power source and the output power resumption unit brings the power output back to the original amount, and further until a second predetermined time period has passed.

36. The high-frequency power supply system according to one of claims 1, 8, 15, 19, 23 and 27, further comprising a second determination prevention unit for preventing the anomaly determiner from performing a determining operation upon commencement by a user of a power supply operation of the high-frequency power source or upon a change made by a user on an output power value setting during power supply operation, until a second predetermined time period has passed.

37. The high-frequency power supply system according to claim 35, wherein the second predetermined time period is longer than a time for the impedance matching unit to perform impedance matching between the high-frequency power source and the load.

38. The high-frequency power supply system according to one of claims 1, 8, 15, 19, 23 and 27, wherein the information detected by the first detector is a power value of the forward wave and the information detected by the second detector is a power value of the reflected wave.

39. The high-frequency power supply system according to one of claims 1, 8, 15, 19, 23 and 27, wherein the information detected by the first detector is a voltage value of the forward wave and the information detected by the second detector is a voltage value of the reflected wave.